Summary WP1a: Security of Supply

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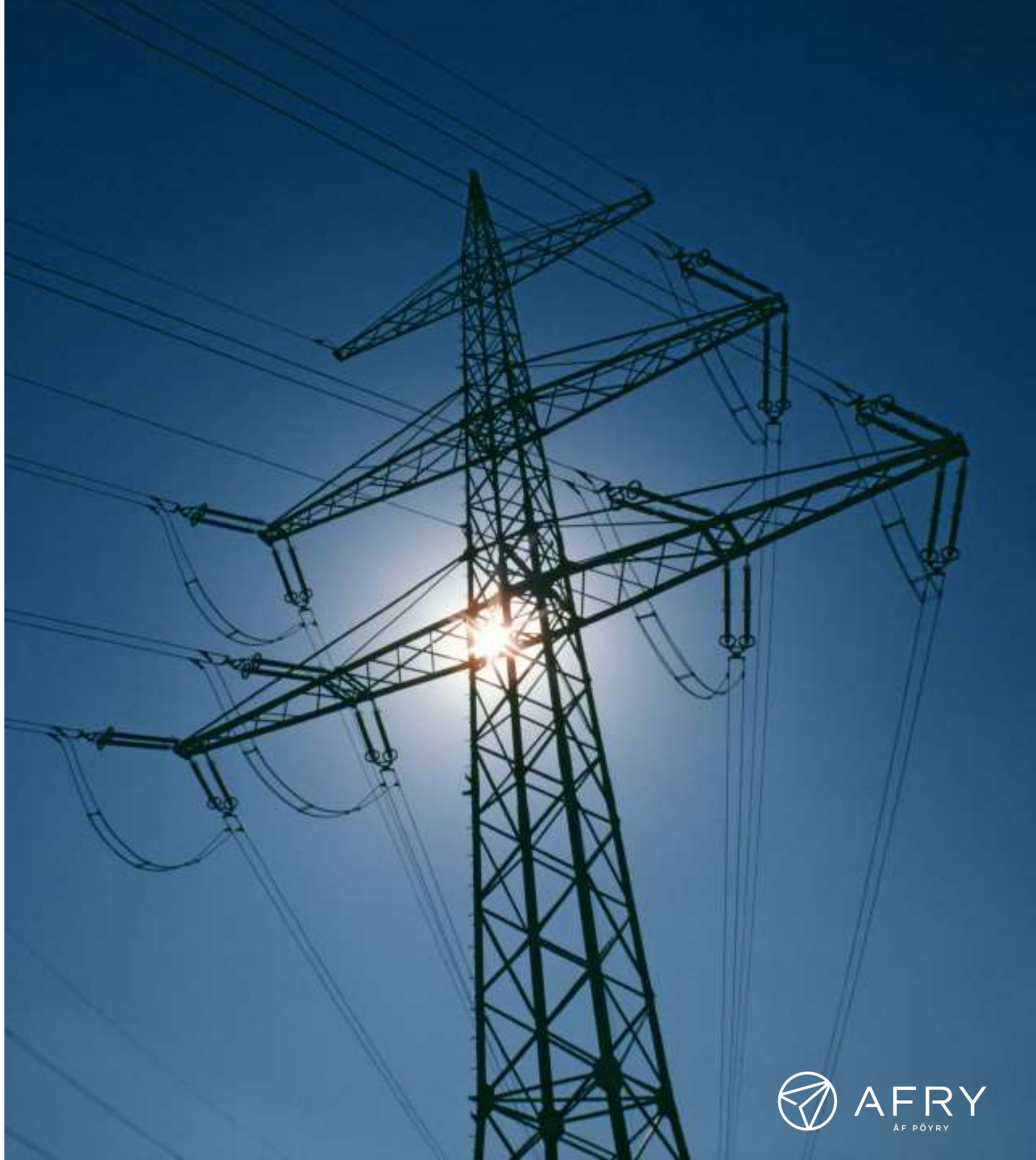
Introduction

In 2021 and 2022, Landsnet has been working with AFRY on a Roadmap for the reform process on tariffs, system contributions, and system services from 2022 to 2024. The Roadmap, which was finalized in May/June 2022, describes a total of sixteen topics that will be evaluated during 2022-2024. Of these, two have been identified by Landsnet as especially urgent: the Security of Supply and Curtailable Transmission. For this reason, Landsnet has initiated the tariff reform process with a first work package (WP1) in 2022 that focuses on these two topics specifically.

This report is a review of different options for changes regarding the first of these topics: Security of Supply (WP1a). The report aims to inform stakeholders about the options that are currently being considered, but is not a recommendation or a proposal for changes in the tariffs. Landsnet expects to propose changes to tariffs at the end of 2022, but invites stakeholders to comment on the options considered before a proposal is developed.

The report has been prepared by AFRY Management Consulting for Landsnet Hf.



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1. Introduction and background

The National Energy Authority, Orkustofnun, has requested that Landsnet implements changes in the transmission tariffs in accordance with the Energy Act. The Energy Act no. 65/2003 (ROL) stipulates that the tariffs DSOs pay to Landsnet should be differentiated based on the security of supply at each delivery point.

At the same time, the Energy Act also contains other requirements that have similar aims as this stipulation and need to be considered in conjunction with it. The four requirements are listed in the text box to the right. Of these, only 1) and 2) pertain directly to Landsnet. The formulation of the other two will however be important when considering how the system should fit together.

Energy Act

Landsnet's work on security of supply is guided by four requirements in the Energy Act:

1) An obligation for Landsnet to **adjust tariffs at each DSO connection point according to the security of supply** at each (Paragraph 2 of Article 12 a ROL)
2) An obligation for Landsnet to pay **compensations for long outages** to DSOs (point 6. Paragraph 3 Article 9 ROL)
3) An obligation for DSOs to pay **compensations for long outages** to end customers (point 8. Paragraph 3 Article 18 ROL)
4) An **incentive system** for network operators (DSOs and TSO) to provide adequate security of supply will be developed through a governmental process. This means that the revenue cap of the network operator may be adjusted based on its performance indicators for the security and quality of supply. See Act 74/2021 and Paragraph 8, Article 12 ROL)

These requirements are not yet implemented.

Approach

AFRY has investigated different solutions to especially the first two requirements while also considering how they could fit with the third and fourth. We have reviewed different approaches used in other countries and developed a shortlist of possible approaches. Before a formal proposal is made, however, we invite stakeholders to comment on the options. Furthermore, the development of the incentive system for both DSOs and the TSO (requirement 4) is a governmental process and not in itself a part of Landsnet's process.

Definitions used in this report

- **Performance indicators** are measurements of the security and quality of supply provided by network operators (DSOs and TSO). The indicators are usually technical, such as the amount of undelivered energy versus delivered energy during a specified period. See the definition of *Security of Supply*.

- **Financial incentives** are the monetary rewards or penalties applied to network operators based on their score on the performance indicators. A financial incentive does not necessarily mean that network operators are penalized for every interruption, but could for example apply if a performance indicator is below a given standard.

- **Compensations** means monetary transfers from network operators to customers due to inadequate security of supply. The compensation can in theory be based on a realized interruption, or on a heightened risk of interruptions. The customer may be an end-customer or a DSO, and the compensation can be a direct payment or a reduction in the customer's tariff. The compensations can be based on the financial incentives, but not necessarily; this depends on the design of the regulation.

- **Security of Supply** is broad term, used to describe the occurrence and chance of interruption in the electrical system. In this report, we use Security of Supply to describe the network operator's ability to deliver an uninterrupted supply of electricity within a given location and time period. We differentiate between the somewhat abstract concept of "Security of supply" and the measurement of it through performance indicators. Indicators provide information about the historical, current, and potentially future security of supply. Such indicators may include:
    - **Redundancy / N-1**. The network's ability to withstand a fault in a single component and still supply the end customers. We often use the term N-1 to denote that the grid will still be in operation after losing any single component.
    - The design and the **state of components**, together with the monitoring and maintenance, would affect the probability of an outage.
    - **Frequency of outages.**
    - **Duration of outages.**
    - Lost **power** and/or lost **energy** is the foundation when finding the value of lost load. This gives an indication of the magnitude of the outage problem.

Current regulation and practice on the security of supply

There is currently no explicit financial incentive system that penalizes or rewards DSOs and the TSO for their performance on security and quality of supply metrics. No explicit compensations are used for long outages, and tariffs that DSOs pay Landsnet do not depend on the security of supply at each delivery point.

Landsnet delivers energy to five DSOs at altogether 62 delivery points. Today, several of these do not have a double connection from Landsnet. Although Landsnet is working on building double connections (N-1) to each point in accordance with government´s policy on the development of the transmission system, this process will not be finalised until 2030 in the main transmission grid and until 2040 in the regional transmission grid. This means that for several years to come, some Landsnet delivery points will have worse security of supply than others.

Today, Landsnet uses both generation reserves and curtailment agreements with DSO-connected customers to preserve security of supply where Landsnet's grid is inadequate. At the same time, however, DSOs have also taken measures on their own to preserve the security of supply for their end customers when there is a fault in Landsnet's grid. DSOs also use Landsnet´s generation reserves as well as their own measures to mitigate disturbances in the distribution grid. The fact that Landsnet and the DSOs sometimes rely on the same resources has led to a question of whether the cost of supplying secure electricity to end-customers is fairly shared between Landsnet and the DSOs.

The changes requested by the Energy Authority suggest that the responsibilities and mutual obligations of the DSOs and the TSO need to be more formalised than they are today.

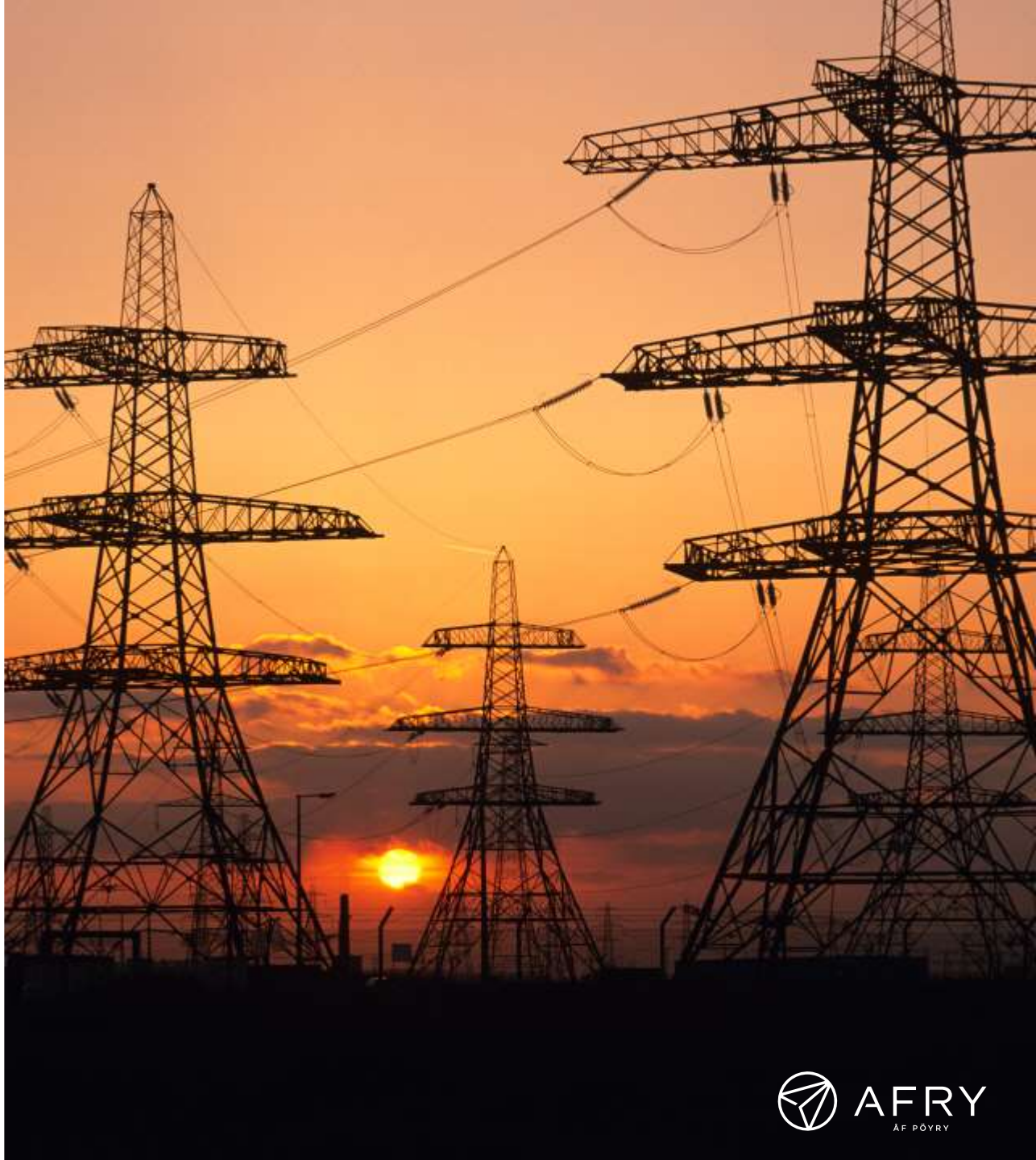
Key questions

The background outlined on the previous pages lead to several questions on how the requested changes can be implemented in practice. While there are many important details, we believe it is possible to summarize the key questions as follows:

1. What are the relevant performance indicators and financial incentives for the TSO and DSOs?
2. To what extent and how should performance indicators be coupled to compensations and tariff discounts? For example, should a financial penalty to the revenue cap of a network company go directly to the affected customers as a compensation?
3. How should TSO-DSO compensations be formulated?

Practice in other European countries

1. Introduction and background for possible changes
2. Practice in other European countries
3. Possible options in Iceland



2. SECURITY OF SUPPLY: PRACTICE IN OTHER EUROPEAN COUNTRIES

AFRY has researched how performance indicators, financial incentives, and compensations based on security of supply is being treated in the regulation of network companies in other European countries, with in-depth explorations of the current systems in the other Nordic countries in particular.

The latest full overview of Europe we have access to is the sixth benchmarking report by the Council of European Energy Regulators (CEER) from 2016 [1], which encompasses EU-28 (including the UK), Norway, and Lichtenstein. Although this report is some years old and some systems may have changed since then, it provides a useful overview of solutions that are or at least have been used in practice and can be considered as options.

According to this report and given that the general picture also holds in 2022, it seems common in European countries to use data on the quality and security of electricity supply to provide financial incentives to network operators. It also appears common to provide direct compensations to affected customers when certain criteria are not met, and in many cases the compensation is automatic.* There is however significant variation in exactly how the countries collect data, define performance metrics, and define the criteria for individual compensations.

As described in [1] – and also with the caveat that this is 2016 data -some countries use estimates for the Value of Lost Load (VoLL) as a basis to determine financial incentives for network operators and/or to set levels for individual compensations. Other countries use what can be called a "standards-based" approach whereby penalties are imposed if a given threshold for an indicator is exceeded. These standards can also partly be based on VoLL estimates, but the link may be implicit and approximate.

Another observation in the 2016 report [1] is that the criteria for granting individual compensations to end-customers are generally stricter than the criteria for penalizing network operators. Typically, individual customers are only compensated for 'long' or 'very long' outages, for which eligibility was reported to range between 1 and 24 hours. Network operators are typically also penalised for shorter interruptions than this, as well as for other breaches of performance standards. The penalties (or in some cases, rewards) can however affect the revenue caps of the network operators and thus the overall tariff level. Hence, end-customers also get some degree of collective compensation for interruptions that do not qualify for individual compensations. The amount received per individual in this way is however diluted and small, and may also be partly offset by the network operators' right to recover their costs. In most cases, penalties only apply when the performance indicators exceed a given standard or "norm".

Another observation from [1] is that the criteria used for individual compensations are generally based on actually occurring interruptions or breaches of performance standards, rather than the risk of that happening. This is relevant because security of supply also can be interpreted in this manner. For example, a connection point with N-1 redundancy could be said to have stronger security of supply than a connection point without, even if no actual interruptions occur during a year. European countries seem, however, to largely base their performance metrics and compensations on actual interruptions.

**An automatic compensation means that the customer does not need to apply to the network company to be compensated.*

Handling volatility in financial penalties and compensations

A regulatory system where network operators are penalised financially for interruptions can raise a concern that the payments could be unpredictable and volatile between years, for example in the case of an extreme event. There are however ways to mitigate this or to dampen the effect.

The CEER 2016 report [1] provides several examples from European countries of measures that can protect network operators from too much volatility in their payments for breaches of security of supply standards. The same kind of measures can also limit the compensation paid to each end-customer, which can also mitigate the possibility of overcompensation and harmful incentives. These measures can take several forms.

The CEER report is now several years old, and we have not researched in detail what may have changed in each country since then. Our purpose here, however, is only provide some examples of solutions that other countries have experience with. Some of these include:

- **A limit to the possible reduction or increase in the network operator's income.** For example, Spain was reported in the 2016 report [1] to use a range from -3% to +3% for "quality incentives" for distribution companies.

- **Exceptions for certain events.** For example, it was reported in the 2016 report [1] that in Great Britain the performance standards for distribution companies are not considered to be breached in the case of "exceptional events". Indeed, the Icelandic Industrial Committee has stated that the compensations paid by the TSO to DSO for long outages, required in the Energy Act, should be exempted in the case of severe weather and natural disasters.

- **Averaging.** Performance could be measured over a rolling, multi-year period rather than year by year. For example, it was noted in the 2016 report [1] that key indicators in Germany are averaged over a three-year period.

- **Caps on individual compensations.** Compensations to end-customers can have absolute caps or caps defined by the tariff payments of the customer. For example, in the 2016 report [1] it was noted that Great Britain uses a cap of £700 per customer/year, while Portugal limits the compensation to be no higher than the customer's tariff payments for the previous year.

Besides these options, a **minimum rate of return** can also act to protect network operators from cost volatility, including from penalties for interruptions. In for example Norway, DSOs have a minimum rate of return (albeit 0% over 5 years) that can mitigate some of the worst outcomes in case of an extreme event.

As the 2016 CEER report is somewhat old, we have taken a closer look at the current regulation used in a selection of countries. We have chosen to focus our attention on the systems used in Denmark, Norway, Finland and Sweden. These countries resemble the Icelandic system in some ways, for example regarding climate, topography, power generation resources, and culture. Furthermore, AFRY's team is based in Finland, Norway, and Sweden, and have first-hand knowledge of the regulatory environment there.

Special focus: the other Nordic countries

Approaches to financial incentives for DSOs and TSO in the other Nordic countries

The other Nordic countries (Sweden, Finland, Norway, Denmark) use different approaches when setting the TSO's revenue cap. In general, it is quite difficult to benchmark and determine the TSO's efficiency. Therefore, the TSOs tend to have a high degree of cost recovery compared with the DSOs. The Norwegian, Swedish and Finnish TSOs have financial incentive systems related to the security of supply. The Danish TSO does not have similar financial incentives. The DSOs in all the Nordic countries have incentives to either maintain, improve or optimize their security of supply.

- The Norwegian TSO uses value of lost load directly when calculating the penalty, called 'KILE'. The DSOs have the same system.
- The Swedish and Finnish TSOs have a reward/penalty system where the TSO gets a higher revenue cap if they exceed the security of supply goal, or a reduction if they underperform.
- The Danish DSOs have a threshold system, whereby DSOs are only penalized if the security of supply indicators exceed a threshold.
- All the Nordic countries have a maximum penalty cap (or reward), except Norway where the penalty could be "unlimited" (furthermore, an exemption of the penalty because of 'force majeure' is uncommon in Norway). However, Norwegian network companies have a minimum rate of return (albeit 0% over five years).
- The Swedish and Finnish TSOs and DSOs, as well as the Danish DSOs, use different indicators to measure security of supply, and setting thresholds/goals based on historical security of supply

Approaches to compensations in the Nordic countries

All the other Nordic countries may be said to compensate customers affected by outages, directly and/or indirectly. In this context, a direct compensation means a payment or tariff discount to the customer(s) directly affected by the outage. An indirect compensation ensues if the network operator's revenue cap is reduced by a penalty, which means a lower tariff for all its customers.

- Sweden, Finland and Norway have some sort of direct compensation to the affected end-customers in case of a long outage caused by the DSO
- All four countries have some sort of indirect compensation to the end-customers in case of a short outage caused by the DSO, insofar as the DSO's revenue cap is reduced by a penalty (DSOs are only effectively penalized for outages beyond a threshold or 'optimal' level)
- Only the Norwegian system incorporates a direct compensation for the affected end-customer in the case of a long outage caused by the TSO
- The Norwegian, Swedish and Finnish systems incorporate penalties to the TSO's revenue cap for breaches of performance standards and/or (suboptimal) interruptions, leading to an indirect compensation to all the TSO's customers
- None of the systems grant fixed tariff discounts from the TSO to the DSOs based on a heightened *risk* of outages, for example for lacking N-1.

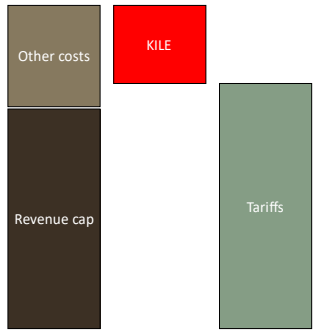
Short interruptions in the other Nordic countries

Norway

THE 'KILE' SYSTEM: incentives for network operators, indirect compensation to the customers

No maximum penalty

The main objective is to give all network operators with a revenue cap, including the TSO, an incentive to optimize the total cost of investments, operational costs and cost of outages (KILE). The KILE is considered as an operational cost in the calculation of the revenue cap, and paid to the customers by reducing the allowable income (i.e. the tariffs). However, the network company recovers an efficiency-adjusted amount of KILE (and other costs) in the next period, as it becomes part of the revenue cap. The value of lost load (KILE) is calculated bottom up for each end-consumer based on yearly consumption.



Sweden

INDICATORS: incentives for network operators, indirect compensation to the customers

Maximum penalty: 5 %

The main objective is to give the TSO and DSO incentives to have a better security of supply that is better than the norm level. Better security of supply results in a higher revenue cap (and higher tariffs), and worse security of supply results in a lower revenue cap (and lower tariffs).

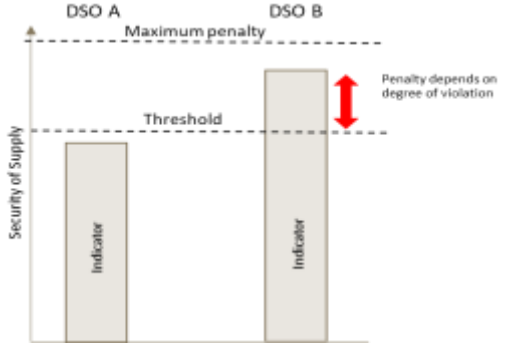
The indicators are frequency and duration of outages, and the calculation is based on non-delivered energy and non-delivered power.

Denmark

A THRESHOLD SYSTEM: incentives for the DSOs, indirect compensation to the customers

Maximum penalty: 4 %

The main objective is to give the DSOs an incentive to have adequate security of supply, which is measured by several indicators based on the frequency and duration of outages. The DSOs are only penalized if they exceed the threshold for the indicator. The thresholds are defined by historical outages. The TSO does not have a similar system.

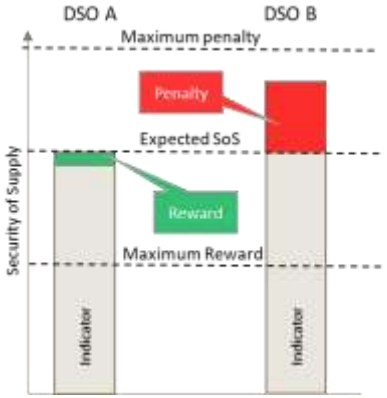


Finland

INDICATORS and REQUIREMENTS: incentives for network operators, indirect compensation to customers

Maximum penalty: DSO 15 %, TSO 3%

The system is similar to that used in Sweden, but the DSOs are also required to design, construct and maintain the grid in such a way that outages longer than 6 hour in urban areas, and 36 hours in other areas, do not occur.



Long outages in the Nordic countries

Norway

THE 'USLA' SYSTEM: direct compensation to affected end-customers, no incentives

Outage time: >12 h

The DSOs must pay the affected customers in the categories "household" and "cabins" in case of an outage of more than 12 hours. The households are paid about €50 for the first 12 hours and €4 for every additional hour thereafter, while the equivalent rates for cabins are about €12.5 + €1 per additional hour. The compensation can not be larger than the expected yearly tariff payment.

The USLA is offset in the revenue cap, thus not giving any incentives to the DSO beyond what is already in the KILE system which covers all forms of outages (long and short). The compensation is paid by the DSO, but if the TSO is responsible, the DSO gets compensated by the TSO. Rules for cost-sharing between DSO and TSO in special cases have been developed by the Norwegian regulator.

Certain customers, if they are large enough, could have a special agreement with the DSO of an individual compensation scheme similar to the KILE-calculation, i.e. compensation from the first second.

Sweden

INDIVIDUAL COMPENSATION

Outage time: >12 h

The amount of compensation is determined by the customers' expected total yearly tariff cost and the duration of the interruption. The affected DSO pays the compensation, but if another DSO is responsible, it will compensate the affected DSO. Outages caused by the TSO will not trigger a compensation to the end-customers.

Furthermore, outages longer than 24 hours in never allowed, and no customer should have more than 11 interruptions per year.

The tariffs have increased in Sweden and Finland because of the strict security of supply requirements, causing dissatisfaction and discussions at the political level.

Denmark

NO INDIVIDUAL COMPENSATION: the Security of Supply is "too good"

Outage time: -

Denmark has one of the best security of supply records in Europe, thus a "negligible" number of customers will ever experience an outage of 12 hours or more. The system for such an individual compensation has been considered to be too expensive compared with the benefits [2].

Finland

INDIVIDUAL COMPENSATION:

Outage time: >12 h

The compensation is a fraction of the expected annual distribution fee, starting at 10% in case of an outage between 12 and 24 hours, and culminating at 200% if the outage is longer than 288 hours (12 days). The annual compensation is maximized at 200 % of the annual distribution fee, or €2 000.

If an interruption is caused by the TSO, no compensation is paid.

The tariffs have increased in Sweden and Finland because of the strict security of supply requirements, causing dissatisfaction and discussions at the political level.

3. Possible options in Iceland

1. Introduction and background for possible changes
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	Compensations to customers affected by outages can address a concern for fairness. Several European countries grant direct (individual) compensations to end-customers for very long outages.
	An incentive system of financial penalties and/or rewards for network operators can lead to faster improvement of security of supply where it is lacking, and potentially (depending on design) lead to optimal expenditure on measures to ensure security of supply

Comment AFRY
The scope of this process is to find a suitable compensation system that fulfils the Energy Act and NEA request. Implementation of an incentive system is separate discussion, and not a part of this report. However, a compensation system could entail incentives. Bad incentives are probably worse than unfairness, thus it is important to reveal harmful incentives in the proposed solutions.

Overview

As described on page 5, the changes requested by the Energy Authority lead to several questions on implementation. To simplify, these can be condensed into three main questions. The first of these concerns the definition of performance indicators for the network operators and is a part of the governmental process.

1. What are the relevant performance indicators and financial incentives for the TSO and DSOs?

2. To what extent and how should performance indicators and financial incentives be coupled to compensations and tariff discounts? For example, should a financial penalty to the revenue cap of a network company go directly to the affected customers as a compensation?

3. How should TSO-DSO compensations be formulated?

In this chapter, we deal with these in turn.

Q1: What are the relevant performance indicators and financial incentives for the TSO and DSOs?

The development of performance indicators is a governmental process and not a part of Landsnet's task. Nevertheless, we briefly discuss some key possible approaches here due to their relevance for the compensation mechanisms required in the Energy Act. While many different variants are possible, two overarching approaches are worth focusing on: the value of lost load (VoLL) and a standards-based approach. The two are not mutually exclusive, and may be used for different indicators of security and quality of supply. Standards may also be based on VoLL estimates, meaning that the distinction is not absolute.

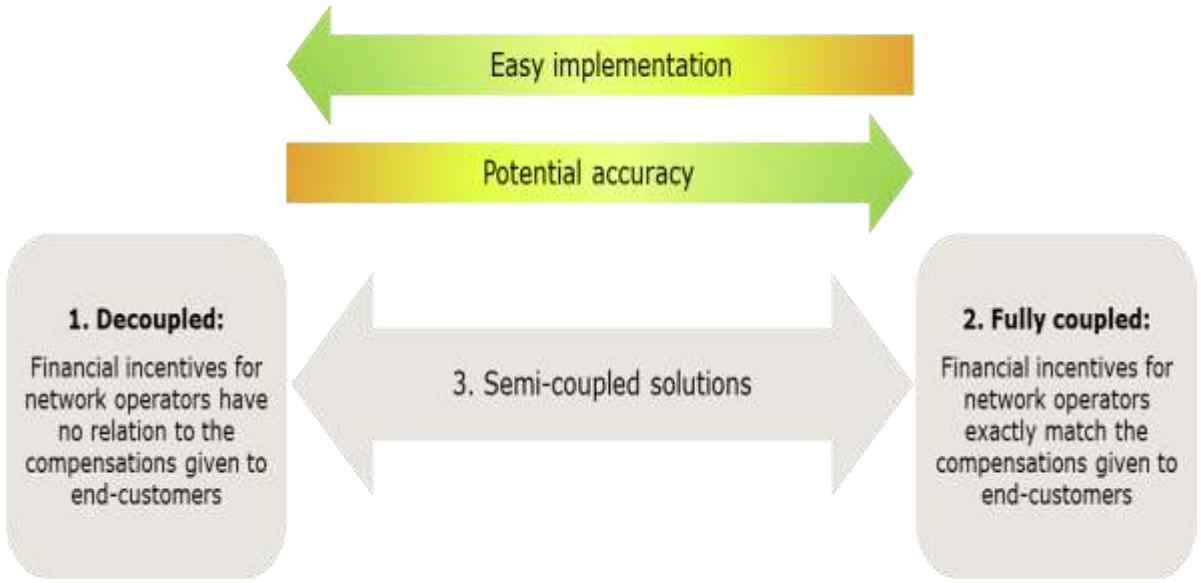
Value of Lost Load (VoLL)	The value of lost load is determined by the end-customers' experienced loss, both in terms of comfort and lost revenue, if the supply of electricity is interrupted. VoLL-based performance indicators are in place e.g. in Norway, Sweden and Finland.
Standards	There are many options in use, for example the number of outages (planned and unplanned), duration of outages, or the amount of non-delivered energy. Two commonly used options are the combination of these; The System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI). A standard could for example be based on the performance of other network companies, the company's own history of outages, or an externally set standard.

Q2: should the compensations be based on the performance indicators and financial incentives for network operators?

The performance indicators and financial incentives planned for network operators in Iceland may be used as a basis for the different kinds of compensations stipulated in the Energy Act. However, it is also possible to use separate methods or something in between. Hence, we can distinguish three main approaches to how the performance indicators and the compensations may be "coupled":

1) "Decoupled": The performance metrics and financial incentives for quality and security of supply constitutes a separate system, and the rates for compensation are based on an entirely different calculation.
2) "Fully coupled": Financial penalties incurred by network operators translate directly into compensations for the ultimately affected end-customers.
3) "Semi-coupled": The performance indicators and financial incentives are constructed as penalties that partly lead to collective tariff discounts or compensations to customers, but not necessarily directed only toward the affected end- customers. This broadly describes the system used in the other Nordic countries, as outlined in chapter 3.

The distinction between a semi-coupled or a fully coupled approach is really a difference in degree rather than in kind. It can be thought of as a continuum between the two "extremes" of a decoupled and the fully coupled approach, as illustrated in the figure to the right.



Q2: Why we in principle favor a «semi-coupled» approach

If the incentives given to network operators were to be fully economically efficient, they would probably be based on the value of lost load (VoLL) for different customer groups. If so, a compensation system motivated by fairness would seem misaligned if the compensations were based on an entirely different calculation than the VoLL. It may appear at least at first glance that the theoretical ideal is to use VoLL both to give financial incentives to network operators and for compensations, and that the system should be highly 'coupled'.

The arguments in favor of more 'decoupling' are partly practical. First, it not yet decided whether the performance indicators and financial incentives currently being developed for network operators in Iceland will be based directly on VoLL calculations or on a system of benchmark standards (see p.18). A standards-based approach is more difficult to translate into compensations for end-customers. Second, the administrative costs of full coupling can be high in comparison with the benefits. In practice, it would mean that every compensation becomes an equivalent penalty for the network operator, and that every financial incentive for the network operator translates into a compensation for an end-customer. We assume that the performance indicators being developed may cover a wide range of interruptions and disturbances, and it will be administratively costly to find matching compensations to end-customers for all of these.

When Norway implemented the KILE system around 20 years ago, it was originally suggested that the penalties for network operators would be paid out to affected customers [3]. As such, it would approach something like a 'fully coupled' solution as we describe that here. However, this was not implemented, and the KILE system is now primarily a financial incentive (see chapter 2). Higher administrative costs was a key reason [4]. The compensation rates from the TSO and DSOs to end customers for very long outages, "USLA", is separate from the incentive system (KILE). Similarly, the Danish Energy Authority argued in 2021 that the administrative costs of implementing the incentives for network operators as direct compensations to the affected customers is generally too high to justify – and in their case, including for long outages [2]. Here, it is however also worth noting that the administrative costs were deemed to be high compared with the compensations that would be paid out if implemented. Hence, the current security of supply can be a factor in determining which level of administrative costs one can justify.

Furthermore, network operators should not necessarily be penalized for every interruption, since the cost of avoiding every interruption would be extremely high. In systems used throughout Europe, our impression is that network operators are typically only penalized when the security of a supply is below a certain standard or norm.* However, it is still possible to consider compensations for individual customers even though the network operator's aggregate performance is within the acceptable range.

In sum, while we see the theoretical benefits of system where the performance indicators are closely linked to compensations, we suspect that the difficulty of practical implementation and the administrative costs of such a "fully coupled" solution would be too challenging.

* The Norwegian system is somewhat special because every interruption becomes a financial penalty for the network operator. However, the regulation ensures that this cost can be recovered just like other costs (e.g. operational- and capital costs), depending on the company's measured efficiency. Hence, the network operator tries to minimise the sum of all costs, and will accept some risk of interruptions because it is suboptiomal to eliminate it completely.

Q3: Different approaches to TSO-DSO compensation

We have considered two main approaches to how Landsnet could compensate DSOs for inadequate security of supply, described below. They are not mutually exclusive and can potentially be combined to fulfill different stipulations in the Energy Act.

Approach	Description	Stipulations in the Energy Act addressed	Variants / further decisions
1.Fixed compensation based on risk criteria and costs of redundancy	Landsnet compensates the DSO for inadequate security of supply by a cost calculation that is not based on realized interruptions but rather a heightened *risk* of interruptions and the DSO's costs of redundancy measures (e.g. backup generators). Lacking N-1 could be a criterion for compensation.	• Lower tariff for delivery points with inadequate security of supply	• Fixed tariff discount or improved incentive to negotiate cost-sharing between TSO and DSO
2. Compensation based on realised interruptions	A compensation to the DSO based on a realized interruption in Landsnet's supply to the DSO	• Compensation for long outages • Lower tariff for delivery points with inadequate security of supply (compensation also for short outages)	• Whether the compensation should go to the affected end-customers • Whether compensation should apply also when end-customers are not affected

Summary of options considered

Lower tariff for delivery points with inadequate security of supply

1. Landsnet applies a fixed percentage discount to delivery points that do not meet a certain criteria, e.g. N-1. Landsnet's own reserves and curtailable customers in the area may count toward fulfilling N-1.
2. Landsnet compensates DSO per interruption to the delivery point according to an agreed rate. Depending on design, Landsnet may offset the obligation if it uses its own reserves or curtailment agreements to secure supply for the end-customers.
3. DSO can seek reimbursement from Landsnet for incurred costs caused by inadequate security of supply. The Energy Authority acts as an arbiter in disputes. The reimbursement is subtracted from the DSO's tariff payments.
4. The performance indicators ensure that Landsnet has a clearer responsibility for interruptions for end-customers if the fault originates in Landsnet's grid. This gives Landsnet a stronger incentive to finance the costs of measures (e.g. reserves, extra network components and curtailment agreements) within the DSO area.

Compensations for long outages from TSO to DSO

1. If end-customers experience a long outage, the DSO compensates them. If the fault is caused by the TSO, the TSO reimburses the DSO.
2. TSO compensates DSO for any interruption longer than the threshold (e.g. 12 hours). The compensation applies even if end-customers do not experience an interruption.

Discussion of alternatives (1)

The two stipulations in the Energy Act pertaining directly to Landsnet are the requirement of lower tariffs at delivery points with reduced security of supply and the requirement of compensations to DSOs for long interruptions. In general, we have identified two main reasons why tariff discounts and compensations may be considered: either to compensate DSOs for the measures they must take because the TSO provides inadequate security of supply, or to compensate the end-customers for actual interruptions.

We assume that the first of these reasons (cost sharing of security of supply investments) is a part of the motivation why the Energy Act stipulates tariff discounts per delivery point. However, it may be that a tariff discount is not the most accurate tool for this purpose. In this part, we discuss how the planned performance indicators for network operators, or possibly other regulatory measures, by itself could lead to more fair cost sharing than today. This could reduce the need to use a tariff discount for the same purpose, although it may still be used to compensate for interruptions and thereby fulfill the Energy Act stipulation.

The performance indicators that need to be developed through a governmental process could entail incentives that lead to more accurate cost sharing between Landsnet and the DSOs for measures that are taken within the DSO's network area due to a lack of multiple connections to the DSO's delivery point. The key mechanism would be to make Landsnet more exposed to the cost of interruptions for end customers when there is a fault in Landsnet's grid. If so, Landsnet would have an incentive to take actions that are "cheaper" than the cost of interruptions. Sometimes, the optimal solution may be found within the DSO's area rather than in Landsnet's own network, and may broadly include for example generation reserves, demand response, energy storage, or additional lines and transformers. The performance indicators can give Landsnet a signal of how much it should be willing to pay for these measures. This can form the basis for more accurate cost sharing between the DSO and the TSO.

It is uncertain if improved cost sharing *in itself* would comply with the stipulation in the Energy Act of adjusted tariffs per delivery point. This would require the tariff discount to be formulated as a reimbursement of the DSO's costs, and it may be that this does not fall under the definition of a tariff discount.

It can, however, mean that an additional tariff discount level should be used with care in order to avoid double compensation. To the extent 'optimal' cost sharing is achieved, there would not be any need for additional incentives through an additional tariff discount.

The purpose of further compensation would then probably be a concern for equity. For example, some consumers may have worse security of supply than elsewhere in the country even after all optimal measures have been taken. Also, as mentioned, the Energy Act may in any case require a tariff discount - even if perfect cost sharing was achieved. In this case, it would make sense to let the tariff discounts be based on actual interruptions in Landsnet's grid that affect end-customers, and not interruptions to the delivery point only. This is because optimal measures to prevent interruptions would presumably have been taken both in Landsnet's grid and within the DSO's area, and both network operators have paid their "right" share.

Notably, if such tariff discounts are given, they would also cover the requirement of TSO-DSO compensations for long interruptions. In one interpretation, the specific compensation for long interruptions stipulated in the Energy Act could even itself be technically sufficient to fulfil the stipulation of differentiated tariffs per delivery point. This is however not our main hypothesis.

Discussion of alternatives (2)

If the tariff discount is introduced in a situation where cost sharing between a DSO and Landsnet is already 'optimal', it will as mentioned probably not have additional beneficial incentive effects. While it still can address a concern for equity in that case, it should be investigated further whether it could have some undesired incentive effects such as certain locational signals or that some customers benefit from interruptions in their area.

It should also be considered that the mechanisms introduced by the performance indicators will probably never lead to perfectly optimal cost sharing. In this case, the tariff discount could be used to move the balance in the right direction if the issue is that the DSOs are still undercompensated. It is quite difficult to set a correct level for this discount, however. It would have to be equal for all DSOs, thus risking to undercompensate some and overcompensate others. Therefore, we think a general tariff discount is not the best instrument to achieve better cost sharing, and should only be used carefully for this purpose, if at all. A general tariff discount seems better suited to compensate customers for actual interruptions than to finance the DSO's additional cost of preventing interruptions.

As several different changes are considered at once, it is challenging to develop a solution that makes all the pieces fit together. While many configurations are possible, we would like to here suggest that one «package» could be built around the following four principles:

- A system of performance indicators that makes Landsnet responsible for realised interruptions for end-customers in the case of faults in Landsnet's grid. If Landsnet would be only penalized for not delivering energy to the DSO delivery point, it could be penalized even if it uses its own back-up generation reserves within the DSO's area to secure continued supply for the end customers.
- When Landsnet's incentive is tied to interruptions for the end-customer (the first point) we expect it will be easier for the DSO and Landsnet to find better cost-sharing agreements, for example by Landsnet renting back-up generation reserves within the DSO area. It may also aid the Energy Authority when arbitrating disputes of cost sharing between TSO and DSO. Over time, this can lead to more fair cost-sharing between Landsnet and the DSOs.
- If the incentives from the performance indicators indeed lead to more fair and optimal cost sharing as described above, there is less justification for an additional tariff discount that seeks to correct the cost sharing imbalance. For example, if Landsnet must pay a compensation to the DSO for an interruption to the delivery point while still maintaining supply to the end customers by Landsnet's own reserves, it would in practice overcompensate the DSO. Hence, given that reasonable cost sharing is achieved through the incentive system, further compensations should only apply when end-customers are actually affected. In this case, the justification for the compensation is the interruption itself, not the costs of preventing interruptions. Our hypothesis is that such compensations, paid out in case of actual interruptions to end-customers, can fulfill both the stipulations in the Energy Act that pertain to Landsnet.
- These compensations (tariff discounts) from Landsnet could go directly to the affected end-customers or to the DSO, leading to a lower tariff for all its customers. The latter option seems to be in closer alignment with the wording in the Energy Act. However, if compensations to end users are also considered, it may be most practical to compensate them directly only for long outages (.e.g. 12 hours or more), due to the administrative cost of direct compensations for all interruptions. The compensations for shorter outages could go to the DSO. This could however be investigated further.

Discussion of alternatives (3)

The ideas outlined on the last two pages have similarities with the system used in the other Nordic countries, perhaps especially the Norwegian one. However, there are several "free parameters" that could make it different:

- The performance indicators and incentives do not necessarily have to directly based on the Value of Lost Load (VoLL), although we expect that VoLL-based indicators will tend to be more efficient.

- In accordance with the Energy Act, compensations to DSOs and/or end users will be used at least to some extent. The other Nordic countries are more restrictive with compensations. In Norway for example, it appears that it is considered sufficient to give all network operators economically efficient incentives, and only grant direct compensations to affected customers in the case of long outages for end consumers.

It also seems clear that the performance indicators in development need to be well designed if they are to lead to improved cost sharing between DSOs and Landsnet. Hence, the idea can be quite dependent on the quality of these indicators. However, we should expect that the indicators improve over time, and be careful before building up a system that tries to accomplish some of the same effects in parallel.

As of today, it is uncertain when the performance indicators will be finalized, and how it will affect the regulation of network operators in Iceland in general. It may be possible, however, to begin using the performance indicators earlier than when they turn into real financial incentives. One example we are exploring is whether a "shadow accounting" of the VoLL from interruptions originating in Landsnet's grid could be used as a steering variable. The idea would be that Landsnet has an incentive to minimize the total sum of its normal costs plus these costs, although the latter are not necessarily paid out. This idea is still in development.

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